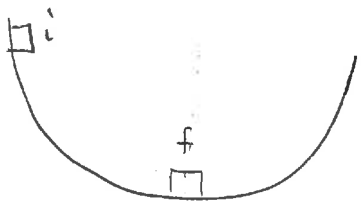
2016 Supp Ex 69

a)



$v_i = 0\ m/s$ $\quad$ $V_f =$

$y_i = r = 10m$ $\quad$ $y_f = 0m$

total mass $= m_{tot} = 65\ kg$

Energy conserved

$$E_f = E_i$$

$$K_f + U_{g}f = K_i + U_g i$$

$$\frac{1}{2}mv_f^2 + \cancel{mgy_f} = \cancel{\frac{1}{2}mv_i^2} + mgy_i$$

$$\frac{1}{2}\cancel{m}v_f^2 = \cancel{m}gy_i \Rightarrow v_f^2 = 2gy_i$$

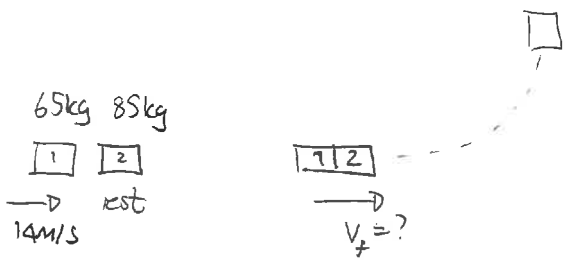
$$\Rightarrow V_f = \sqrt{2gy_i}$$

$$= \sqrt{2 \times 9.8 m/s^2 \times 10m}$$

$$= 14 m/s$$

b) Momentum is conserved during collision

$$P_{tot\,i} = P_{tot\,f}$$



$$m_1 v_{1i} + \cancel{m_2 v_{2i}} = (m_1 + m_2)\ v_f$$

$$v_f = \frac{m_1}{m_1 + m_2} v_{1i} = \frac{65kg}{150kg}\ 14$$

$$\Rightarrow V_f = 6.1 m/s$$

After this energy is conserved:

highest $\swarrow$ bottom

$$E_f = E_i$$

$$\cancel{\frac{1}{2}mv_f^2} + mgy_f = \frac{1}{2}mv_i^2 + \cancel{mgy_i} \Rightarrow y_f = \frac{v_i^2}{2g} = \frac{(6.1 m/s)^2}{(2 \times 9.8 m/s^2)} = 1.9\ m$$

Knight ~~Ch~~ Ch 11

2ed Conc Q6

bullet block

In both cases the total momentum is conserved and in both cases, before collision,

$$P_{tot\,i} = P_{bullet\,i}$$

and these are the same. So the total momentum after the collision is the same in both cases. Assume that they are positive

Wood

V_{wf}

Here

$$P_{tot\,f} = (M_{bullet} + M_{wood}) V_{wf}$$

Here $(M_b + M_w) V_{wf}$ is same as $P_{tot\,f}$

Steel

V_{bf} negative V_{sf} positive

$$\underset{pos}{P_{tot\,f}} = \underset{pos}{M_s V_{sf}} + \underset{neg}{M_b V_{bf}}$$

Here V_{bf} is negative so $M_s V_{sf}$ is larger than $P_{tot\,f}$, so that is compensates for the negative bullet momentum.

Combining these gives $M_s V_{sf}$ larger than $(M_b + M_w) V_{wf}$

So V_{sf} larger than $\frac{M_b + M_w}{M_s} V_{wf}$

This is larger than 1 and so it increases the effect.

V_{wf} must be smaller than V_{wf}.

We see two contributions – the negative bullet velocity after means larger block velocity after. ⇒ smaller wood
– the larger wood + bullet mass also means smaller wood velocity after

4ed Knight ~~Ch 9~~ Ch 11

Conc Q 13

a) If both were at rest after then $\vec{p}_{final} = 0$

But $\vec{p}_{initial} \neq 0$ and conservation of momentum prohibits this.

Impossible

b) Initial

$p_i = m_A v_{Ai} > 0$

After B cannot be at rest since if A rebounded $p_f < 0$ and $p_f \neq p_i$. So A could be at rest with B →

Conc Q 14

a) $p_i = 0 \Rightarrow p_f = 0 \Rightarrow p_{fP} + p_{fR} = 0.$

$$\Rightarrow p_{fP} = -p_{fR}$$

So both have same magnitude of momentum.

b) $p_{fP} = -p_{fR} \Rightarrow m_P v_{fP} = -m_R v_{fR}$

$$\Rightarrow v_{fP} = -\frac{m_R}{m_P} v_{fR}$$

> 1

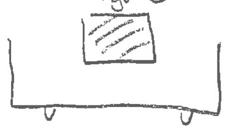
Paula has larger velocity.

4ed Knight Ch11

Prob 15

Before

$V_{gi} = 0$



$V_{ci} = 2.0 m/s$

After

V_f = same for both = ?

$$P_{tot\,i} = P_{tot\,f}$$

$$\Rightarrow M_g V_{gi} + M_c V_{ci} = M_{both} V_f$$

$$\Rightarrow V_f = \frac{M_g \cancel{V_{gi}} + M_c V_{ci}}{M_g + M_c} = \frac{M_c}{M_g + M_c} V_{ci} = \frac{1.00\cancel{0}\cancel{0}\,kg}{14.\cancel{0}\cancel{0}\cancel{0}\,kg} \, 2.0 m/s$$

$$= 1.43 m/s$$

4ed Knight Ch 11

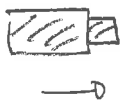
Prob 18

Before

Bird Insect

$V_{Bi} = 6.0 m/s$ $V_{Ii} = -30 m/s$

After



Both (BI)

$V_f = ?$

No net external force $\Rightarrow$ total momentum conserved.

$$P_{tot\,i} = P_{tot\,f}$$

$$m_B V_{Bi} + m_I V_{Ii} = m_{BI} V_f$$

$$\Rightarrow V_f = \frac{m_B V_{Bi} + m_I V_{Ii}}{m_{BI}}$$

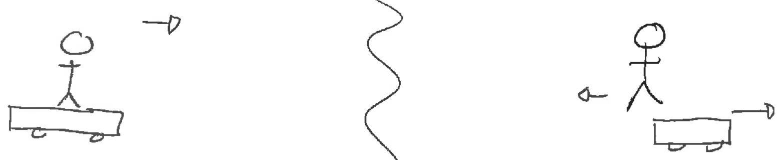
$$= \frac{0.300kg \times 6.0 m/s + 0.010kg(-30 m/s)}{0.310kg}$$

$$= 4.8 m/s \longrightarrow \text{(right)}$$

4ed Knight Ch 11

Prob 28

Initial | Final



$V_{Di} = 4.0 m/s$ | $V_{Df} =$

$V_{si} = 4.0 m/s$ | $V_{sf} = 8.0 m/s.$

No net external force $\Rightarrow$ $P_{tot\,f} = P_{tot\,i}$

$$\Rightarrow M_D V_{Df} + M_s V_{sf} = M_D V_{Di} + M_s V_{si}$$

$$\Rightarrow 50kg\, V_{Df} + 5.0kg \times 8.0m/s = 50kg \times 4.0m/s + 5.0kg + 4.0m/s$$

$$\Rightarrow 50kg\, V_{Df} + 40kg\,m/s = 200kg\,m/s + 20kg\,m/s$$

$$\Rightarrow 50kg\, V_{Df} = 180kg\,m/s$$

$$\Rightarrow V_{Df} = 3.6m/s \quad \text{forwards}$$

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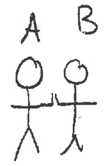
Prob ~~#~~ 29

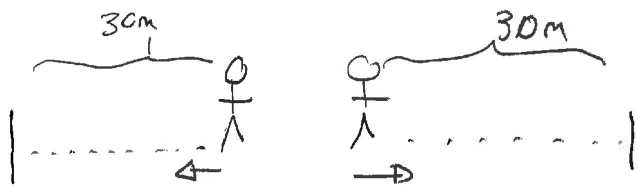
Initially



$M_A = 50kg \qquad M_B = 75kg$

$V_{Ai} = 0m/s \qquad V_{Bi} = 0m/s$

Finally



$V_{Af} = ? \qquad V_{Bf} = ?$

No net external force $\Rightarrow$ total momentum conserved.

$$\Rightarrow \quad p_{tot\,i} = p_{tot\,f} \quad \Rightarrow \quad p_{Ai} + p_{Bi} = p_{Af} + p_{Bf}$$

$$\Rightarrow \quad M_A \underbrace{V_{Ai}}_{=0} + M_B \underbrace{V_{Bi}}_{=0} = M_A V_{Af} + M_B V_{Bf}$$

$$\Rightarrow \quad M_A V_{Af} = M_B V_{Bf}$$

$$\Rightarrow \quad V_{Af} = \frac{M_B}{M_A} V_{Bf}.$$

Both travel 30m at constant speeds. So for each $V_f = \frac{\Delta x}{\Delta t} = \frac{30m}{\Delta t}$

Thus $\Delta t = 30m / V_f$ and

$$\Delta t_A = 30m / V_{fA}$$

$$\Rightarrow \quad \Delta t_A = 30m \Big/ \frac{M_B}{M_A} V_{Bf} = \frac{M_A}{M_B} \frac{30m}{V_{Bf}}$$

But $\Delta t_B = 30m/V_{Bf}$ $\Rightarrow$ $\Delta t_A = \frac{M_A}{M_B} \Delta t_B = \frac{50kg}{\ldots} \times 30s$

$\Rightarrow \; v_{Bf} \; \Rightarrow \; \Delta t_A = \frac{}{m_B} \; \Delta t_B = \frac{}{75kg} \times 205$

$= 13.3s$

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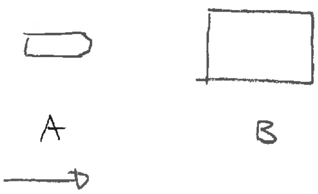
a). Before

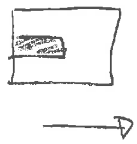
bullet　　block



A　　B

V_{bullet}　　$V_{Bi} = 0$

Immediately After



$M = M_A + M_B = M_{total}$

V_{joint}

Momentum conservation

$$P_i = P_f \Rightarrow M_A V_{bullet} + \cancel{M_B V_{Bi}} = (M_A + M_B)\, V_{joint}$$

$$\Rightarrow V_{joint} = \frac{M_A}{M_A + M_B} V_{bullet}.$$

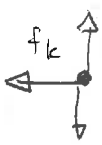
Slides to stop

i　　f

$$V_f^2 = V_i^2 + 2a_x \Delta x \qquad V_i = V_{joint} \qquad V_f = 0$$

$$\Rightarrow -V_{joint}^2 = 2a_x d \Rightarrow V_{joint} = \sqrt{-2a_x d}$$

Newton's 2nd Law



f_k　$\vec{n}$　F_G

$$\sum F_{ix} = M_{total} a_x \qquad \sum F_{iy} = 0$$

$$\Rightarrow n = M_{total}\, g$$

$$\Rightarrow -\mu_k n = M_{total} a_x \Rightarrow a_x = \frac{-\mu_k \cancel{M_{total}} g}{\cancel{M_{total}}}$$

Then $V_{joint} = \sqrt{2\mu_k g d}$

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$$\frac{M_A}{M_A + M_B} V_{bullet} = \sqrt{2\mu_k g d}$$

$$\Rightarrow V_{bullet} = \frac{M_{bullet} + M_{block}}{M_{bullet}} \sqrt{2\mu_k g d}$$

b) $$V_{bullet} = \frac{10.01\,kg}{0.010\,kg} \sqrt{2 \times 0.20 \times 9.81\,m/s^2 \times 0.050\,m}$$

$$= 443\,m/s$$